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AUTHOR Hanson, Marlys C.
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ABSTRACT

Opportunities for scientists in the near future will be very good in the fields of energy research and development, both for degreed scientists and for technicians. Geologists, geophysicists, mining engineers, rock mechanics, hydrologists, applied physicists, applied chemists, and nuclear engineers are among the types of personnel needed. These are fields that have traditionally been "male" enclaves. If women are to take advantage of the opportunities in science, they need more training and more exposure at an earlier age to nontraditional fields; they need to be around mechanics and engineers; they need to take shop and learn to rebuild auto engines so they can get out of the office environment and into the fields where the jobs will be. Girls should be actively recruited into the courses that are non-traditional for females at an early age. They should also learn career planning and development and continue it throughout their careers. (Appendixes include data on hiring and categories of scientists at the University of California Lawrence Livermore Laboratory; national statistics on percentages of women in various scientific fields; and a bibliography of materials on careers in science.) (KC)

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)"

Presented by

Marlys C. Hanson

In structuring my remarks for this discussion group, I have decided to orient my comments around three basic questions that we use in the Career Planning Program for employees at Lawrence Livermore Laboratory.

The questions:

Who am I?

Where am I going?

How am I going to get there?

These are timeless questions - in that we are finding are as valid for a 40 year-old professional scientist as they are for your high school students - for the questions force us to deal with defining interests and values, making decisions, setting goals, seeking information, making commitments.

The first question - Who am I? - involves assessment of just what it is one wants from life - and what interests and abilities one possesses. As there is considerable material available on the assessment process - and it is not the subject of our discussion group - I will not dwell on this question.

The second question - Where am I going? - gets more to the point of the discussion of jobs for women in science, and there are two parts to this question - Where do I want to go? abd Where will the opportunities be? In the traditional areas of chemistry, physics, biology, mathematics? Or will the opportunities be more plentiful in fields of applied science? Where are the best opportunities for women in science? These are some of the areas I will discuss.

The third question - How am I going to get there? - is where you, as educators, get into the act, and I will comment on that question briefly as I summarize my remarks.

So - back to the question of Where am I, as a student interested in a career in science - going? Where will the action be? In response, let me suggest the age old techniques of investigating resources, and then share with you some of the results of my own investigation on this subject.

Some of the resources I used were scientific periodicals/journals, literature from business/industry, and discussion with professionals in the field.

What did I find? For one thing, a great deal of discussion on the impact of energy research and development on creating jobs in various fields of applied science. Another finding was the increasing opportunities as science technicians. Let us look more closely at these items:

First of all, there are several sources of energy - solar, geo-thermal, oil, gas, coal, nuclear fusion and fission, and oil shale are probably the most important ones. I am going to talk just a bit about each of these areas - and while I am doing so, I would like you to be thinking about the kinds of jobs involved.

One of the major traditional sources of energy is coal. There are great amounts of coal in the Western U.S. - much of which could be surfaced mined, but it would create immense environmental problems. Air pollution would also be a problem in converting coal to electricity. Coal gasification is an alternative way of using the source - this means lighting fire to the coal where it is - this creates a gas, which is processed and put in a pipeline (or preferably used to generate electricity at the surface). Solution mining may be another alternative, wherein the coal is put in a solution and brought to the surface.

Oil exists in many reservoirs which require different techniques for extraction. Water flooding or sweeping is one method; using soaps or other petroleum products to

emulsify oil and bring it to the surface is another technique. Explosive stimulation, using regular or nuclear explosives is used to stimulate flow, as are hydraulic fracturing methods, which involves pumping liquids into open pathways to increase flow. Natural gas is another energy resource - but in much shorter supply. Stimulation techniques used with oil are also used to get gas out of tight reservoirs.

Much research is being done with solar energy - and problems exist with low conversion efficiencies and unreliability. Geo-thermal energy has related pollution problems as minerals tend to dissolve in the hot water - the various salts dissolved in the hot fluid can be a special problem here.

Another type of energy is Nuclear fusion - the thermo-nuclear burning of heavy hydrogen in sea water. This appears to be the only unlimited source of energy and is believed to be non-polluting. This energy source needs much research in engineering, chemistry, physics. One of the problems is around materials - the very high temperatures involved require special materials for handling and containment. Nuclear fusion holds another promise, too - and this is an energy source that is an alternate to burning all of our hydrocarbons (coal, gas, oil) which are also sources for plastics, polyesters, nylons, and the many other materials and products that contribute to our society. Nuclear fission, with its well-publicized problems of disposal of dangerous wastes, has promise of supplying great amounts of energy. Nuclear energy has other problems - locating uranium and mining low grade uraniumores - problems with radioactive wastes, but it is in most scientists' minds, the only hope of meeting the world's needs for energy by the end of this century.

Oil shale is rock-like substance that can contain 10 to 40 gallons of oil (kerogen) per ton of rock - but the retorting process of removing the oil leaves mountains of spent shale - and mountains of environmental problems as well. An alternative is in-situ mining techniques - extracting the oil in place.

Now when I begin this discussion on energy sources, I asked you to think about the kinds of jobs involved as I discussed the sources and problems around related research and development of the source.

Let us look then more closely at the types of applied scientists and engineers that will be most likely to find job opportunities in the growing field of energy.

In location identification - finding gas, coal, oil, etc., there would be need for geologists, geophysicists, mining engineers.

In extracting fluids from the ground, a need for chemists, engineers of all types - but also a specialized type called a reservoir engineer - a specialist in location and removal of oil-gas, water, from its natural location, also for rock mechanics, hydrologists.

In the conversion, transfer and storage of all types of energy - mechanical engineers with strong power background, applied physicists, chemists, heat transfer specialists.

In Porous Flow Problems - applied physicists, petroleum engineers, geophysicists, hydrologists, chemists.

In the Chemical In-Situ Mining Processes - metallurgists, chemists, engineers, (especially civil, mechanical, and chemical), physicists.

In Environmental Problems - (Land, air, water pollution and conservation), chemists, engineers, environmental specialists, hydrologists, meteorologists, applied physicists.

In Nuclear energy - material and optical engineers, nuclear engineers, physicists, metallurgical specialists.

There is an obvious move toward integration of the disciplines in energy research to interrelate, to communicate; pure theorists are too isolated and not as marketable as applied scientists. Most of these applied areas are non-traditional for women -

and thus the opportunities should be greater.

There is another area of jobs involved in the energy field - and that is the support occupations - the technicians and instrumentation specialists who do the measurements, the laboratory testing, the retrieval of data, the mineral assays, the materials studies - and again most of these areas are non-traditional for women with more opportunity possible. This is also the area of less than four years degree - the AA degree level.

Now - to the third question - How do I get there? And this is, of course, where we as parents and as educators can get in the act - and I am going to talk now specifically about helping girls and women get there.

In interviewing the scientists and employment recruiters who contributed the information I have presented here today, there were some common threads in their comments - let me pass them on to you.

1) The "soft" sciences of biology, pure chemistry, zoology, theoretical math are well represented with women - who are having a difficult time finding a market for their degrees. Many are accepting positions as lab assistants. Opportunities are equally as good as for men, but not better.
2) The field of computer science is well represented with women, but primarily in programming, computer operators and keypunch operators.
3) Some areas are not well represented by women - electronics, physics, engineering are examples. Scientific institutions have set goals for increasing their representation of women for these disciplines.
4) Women need more preparation for the work environment of non-traditional fields. They also need more applicable education background.

In the work environment, they need to become accustomed to working with machines, with noise, with a non-office environment - smells of chemistry labs - dust of a

mineral assay lab - the language and behavior of the working class. This familiarization needs to begin in early years - with more exposure to mechanics, engineers, tools - the exposure being necessary to stimulate interest in this area. Girls need to take shop in school, to work in gas stations, to overhaul engines. They need exposure to the different work environments with field trips, work experience programs, class speakers, films and other media.

A report of a MIT Conference on Women in Science and Technology outlined recommendations for increasing the representation of women in non-traditional roles in science and technology. I would like to share some of those recommendations with you.

1) To experiment with methods that would attract girls to mathematics, science, shop and technical courses.
2) To actively recruit girls for vocational programs that traditionally enroll only males. Non-discriminatory regulations are necessary but are not sufficient to get them in non-traditional activities at an early age.
3) To build in methods of in-service training for teachers that encourages summer employment which gives credit on the salary scale - or in some way stimulates teachers to get out and find out how their subject matter applies to the world of work.
4) As an educator, keep abreast of science and important research efforts so you are aware of possible trends. In an effort to help you with this, I am providing a bibliography of some very recent articles and books on this subject.
5) To take account of the significance of the school's physical education programs role in forming male and female attitudes about sex roles.
6) To actively encourage girls to take courses that develop their abilities to cope with different environments - like machine shop, electronics, and vocational agriculture.

I think this covers what I wanted to share with you this afternoon about the need for women to prepare for and be aware of the non-traditional opportunities in the field of science.

There is one final point - the importance of making students aware of the continuous process of career planning and development. Traditionally, career decisions were thought to be subject for high school seniors only - but a rapidly changing industrial society has made career planning and development a life-long process. In the Career Planning Program at Lawrence Livermore Laboratory, we emphasize the need for continued monitoring of one's career process - for a need to assume responsibility for one's career - not to delegate such an important task to one's boss - or the company - and expect to be "taken care of". And of course - to be always conscious of the three questions - Who am I? Where am I going? and What am I going to do to get there?

Karol Ruppenthal of the Office of Equal Opportunity at Lawrence Livermore Laboratory has gathered some data that reports various data related to this topic. Jack Brewer, Manager of Employee Development at Lawrence Livermore Laboratory will present this data (attached) and answer any questions you may have.

UNIVERSITY OF CALIFORNIA LAWRENCE LIVERMORE LABORATORY

FISCAL YEAR 1974 - 1975 HIRING

PROFESSIONAL JOB GROUPS	TOTAL	PhD	MS	BS	Less than BS
Administrative Professionals	31	2	9	17	3
Engineer - Mechanical Engineering	49	17	24	8	
Engineers - Electronics Engineering	36	10	19	6	
Engineers - Other	12		1	10	1
Mathematicians & Programmers	69	8	30	31	
Chemists & Metallurgists	37	17	10	10	
Health & Safety	14	1	9	4	
Life Scientists	25	12	9	4	
Physicists	120	81	26	13	

TECHNICAL JOB GROUPS	TOTAL	NO DEGREE	AA	BS	BS+
Drafting & Mechanical Technicians	67	27	26	14	
Electronics Technicians	65	32	29	4	
Math & Computing Technicians	54	23	25	6	
Health & Safety	26	3	9	14	
Technical Illustrators	8	2		6	
Other Technicians	44	21	4	18	1

University of California

Lawrence Livermore Laboratory

SPECIAL PROGRAMS TO PROVIDE TECHNICAL WORK EXPERIENCE

I. AFFIRMATIVE ACTION HIRES

The intent of this program is to train applicants who have completed academic requirements, but are lacking in experience, or individuals who have work experience that is not specific to job requirements. Applicants are trained for one year for a professional or technician level job. Over 90 percent of those who complete the program are hired into permanent full-time jobs at the Laboratory. The emphasis is on minorities and women in technical disciplines.

II ON-THE-JOB-TRAINING

This program provides one year of training to economically disadvantaged individuals or for individuals excluded from employment opportunities based upon race or sex. Trainees with few or no marketable skills are trained in skills which provide a likelihood of employment both within and outside the Laboratory, typically technician-level or clerical jobs. The emphasis is on minorities and women.

III WORK EDUCATION EXPERIENCE PROGRAM

This program provides part-time (school year) and full-time (summer) work experience to high school and college students whose academic interests are in the technical fields. Emphasis is on women and minorities.

IV CO-OP EDUCATION

This program is designed to provide practical R & D experience for scientific and engineer students to supplement and reinforce their classroom work. Students typically alternate six months study with six months work. The program is interdisciplinary and is open to both undergraduate and graduate students.

V STUDENT EMPLOYEE PROGRAM

Designed to provide research experience and financial assistance for the scientific graduate student, LLL's student employee program offers half-time employment for nine months and full-time summer employment for students of the Division of Applied Science (a branch of the University of California - Davis) located on the LLL site. The program is limited to approximately 50 students, primarily physics and computer science majors at MS and PhD level. For further information, contact Dr. Fred Wooten, (415) 447-1100, Ext. 8921.

Inquiries regarding Programs I-IV may be directed to Manuel Perry, Office of Equal Opportunity, (415) 447-1100, Ext. 3951.

ESTIMATES OF NATIONAL WORK FORCE REPRESENTATION OF WOMEN IN MAJOR TECHNICAL DISCIPLINES*

Discipline	Caucasian Women % Total	Minority Women % Total
Engineers	1.6	.7
Programmers & Mathematicians	20.7	2.2
Biologists	33.9	3.1
Geologists	3.4	.2
Chemists	11.0	1.8
Physicists	4.6	.9
Technical Editors/Writers	12.6	1.8

ESTIMATES OF STATE OF CALIFORNIA WORK FORCE REPRESENTATION OF WOMEN IN MAJOR TECHNICIAN OCCUPATIONS

Occupation	Caucasian Women % Total	Minority Women % Total
Mechanical Technicians	3.3	1.5
Electronics Technicans	5.3	2.1
Chemical Technicians	10.3	4.3
Bio-Medical Research & Medical Technicians	58.0	9.1
Draftspersons	9.6	2.2
Mathematical Technicains	No Census Data Available (However, women comprise 28% of the Laboratory's Digital Computer Operators and Computer Technicians)	

* Based on data collected by the 1970 Census and the 1970 EEO-1 Report for 45,000 federal contractors. Summary prepared by UC Lawrence Livermore Laboratory.

BREAKDOWN OF PROFESSIONAL AND

TECHNICAL JOB GROUPS

UNIVERSITY OF CALIFORNIA LAWRENCE LIVERMORE LABORATORY

PROFESSIONALS

JOB GROUP	% OF TOTAL
ADMINISTRATORS	8.5
ENGINEERS	32.0
PROGRAMMERS/MATHEMATICIANS	13.4
LIFE SCIENTISTS	2.8
CHEMISTS/METALLURGISTS	11.9
PHYSICISTS	29.1
TECHNICAL EDITORS/WRITERS	1.4
TECHNICAL INFORMATION SPECIALISTS	.7
NURSES	.2
	100% (1755)

TECHNICIANS

MECHANICAL TECHNICIANS	31.3
ELECTRONICS TECHNICIANS	26.9
CHEMISTRY TECHNICIANS	10.8
PHYSICS TECHNICANS	4.3
BIO-MED & RESEARCH TECHNICIANS	1.4
EXPEDITERS	2.4
DRAFTSPERSONS	8.2
MATH & COMPUTING TECHNICIANS	9.8
TECHNICAL ILLUSTRATORS	1.5
PHOTOGRAPHERS & REPRODUCING TECHNICIANS	3.1
GLASSBLOWERS	.3
	100% (1489)

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